Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF WATER LEAKAGE DETECTION OF HOUSE PIPE SYSTEM

MOHAMAD NAJMI BIN ABDUL NASIR

Bachelor of Computer Engineering Technology (Computer Systems) with Honours

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DEVELOPMENT OF WATER LEAKAGE DETECTION OF HOUSE PIPE SYSTEM

MOHAMAD NAJMI BIN ABDUL NASIR

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in partial fulfillment of the requirements for the degree of
Bachelor of Computer Engineering Technology (Computer Systems) with Honours

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DECLARATION

I declare that this project report entitled "Development of Water Pipe Leakage of House System" is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : 

Student Name : Mohamd Najmi bin Abdul Nasir

Date : 11/01/2022

APPROVAL

I hereby declare that I have checked this project report and in my opinion, this project report is adequate in terms of scope and quality for the award of the degree of Bachelor of Computer Engineering Technology (Computer Systems) with Honours.

Signature : Azman Awang Teh

Supervisor Name : Azman bin Awang Teh

Date : 11/01/2022

Signature :

Co-Supervisor :

Name (if any)

Date :

DEDICATION

My dissertation is dedicated to my family and many friends. Mrs. Bedah, my beloved mother, whose words of encouragement and push for persistence continue to echo in my ears. Najwa, Shafira, and Shafikah, my sisters, have never left my side and are very dear to me.This dissertation is also dedicated to my numerous friends who have helped me during the process. I'll be eternally grateful for everything they've done for me, especially Sarah Amira's assistance in developing my hardware and software abilities, and my supervisor's many hours of proofreading report.

ABSTRACT

Without a doubt, water is the most valuable resource on the planet. However, if there is a potential for a third world war, it will be due to a worldwide water shortage. Therefore, water pipeline monitoring becomes a vital and practical method of preventing massive water waste to avoid such a circumstance. The article's primary goal is to create a leak and water monitoring system based on the Internet of Things (IoT) that will be used to detect leakage of water pipelines in the house. This IoT used a NodeMCU ESP32 as a microcontroller to control the input and output of the system, while Wi-Fi. Two sensors will be used: a flow sensor for the rate of a flow sensor. The observation will be made when the project is completed and can running correctly. This project is simple to use and user-friendly, and it has improved the detection and monitoring of water leaks in the house.

ABSTRAK

Tidak dinafikan, air adalah sumber yang paling berharga di planet ini. Walau bagaimanapun, jika terdapat potensi untuk perang dunia ketiga, ia akan disebabkan oleh kekurangan air di seluruh dunia. Oleh itu, pemantauan saluran paip air menjadi kaedah penting dan praktikal untuk mencegah pembaziran air besar-besaran untuk mengelakkan keadaan sedemikian. Matlamat utama artikel itu adalah untuk mencipta sistem pemantauan kebocoran dan air berdasarkan Internet of Things (IoT) yang akan digunakan untuk mengesan kebocoran saluran paip air di dalam rumah. IoT ini menggunakan NodeMCU ESP32 sebagai mikropengawal untuk mengawal input dan output sistem, manakala Wi-Fi. Dua penderia akan digunakan: penderia aliran untuk kadar penderia aliran. Pemerhatian akan dibuat apabila projek siap dan dapat berjalan dengan betul. Projek ini mudah digunakan dan mesra pengguna, dan ia telah meningkatkan pengesanan dan pemantauan kebocoran air di dalam rumah.

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LIST OF ABBREVIATIONS

L	-	Litres
min	-	Minutes

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1

INTRODUCTION

1.1 Background

Small and medium-sized leaks in residential plumbing are frequently disregarding, even though they can dramatically increase household water demand. Leaks from dripping taps and toilet cisterns can go undetected below ground. Leaks can seem negligible when considered individually, but they result in a substantial water loss when considered collectively over time. Depending on the type and size of the leak, the rate of water loss can vary. In recent years, Malaysian water authorities have expressed concern about long-term water management [18] due to high records of NRW rates. Pipe materials exacerbate water loss, distribution system component joining practices, initial system component installation, water temperatures, and external environmental conditions [15]. Asbestos-Cement (AC), Mild Steel (MS), Ductile Iron (DI), Polyethylene (PE), Galvanized Iron (GI), Acrylonitrile Butadiene (ABS), Cast Iron (CI), and Un-Plasticized Polyvinylchloride (UPVC) are the most popular types of pipes used in Malaysia's water distribution system (uPVC) [14].

Leak detection in water pipelines; pipeline networks carry essential water, oil, and gas. Any pipe leak results in significant financial losses as well as potential environmental harm. Water pipe leaks may allow pollutants to reach water systems, lower water quality, and pose a health risk to water users.

Historically, leak detection has assumed that all leaks come to the surface and are visible. Water distribution infrastructures that are generally old and therefore breakable is the critical cause of leaks. Leaks are difficult to detect because pipes are not readily apparent

and available. Water agencies are forcing to draw more water from lakes and streams due to water supply system losses, placing more stress on aquatic environments. When a leak is discovered, the water company must respond quickly to prevent water loss in the delivery system. These losses are reduced by accurately locating and repairing leaking water pipes in a delivery system. Leaks jeopardize the safety of the water supply network. Households and businesses are forcing to evacuate, pursue alternative sources of potable water, or take other costly steps to protect themselves from the threat of running out of water.

In this project, the water system will be monitor by a device and will alarm the owner to see if the early-stage leaking occurs. The detection device will be enabled to monitor water pipeline leakage every day and anytime. When the leak occurs, it will send the notification through an application to inform the owners about leakages happens.

1.2 Problem Statement

A home's plumbing system is a complex water pipeline network with water supply pipes, drain pipes, and vent pipes. Plumbing due to the convoluted and the high-priced systems to fix or install in a home. These days, a well-designed system will make sure the water flow throughout the pipe system systemically follows the system design. Although the system is systemically correct, can it be repaired and reduced if the leakage happens in the water pipeline?

This project aims to monitor the water pipe system 24 hours a day, seven times a week, by detecting the early stage of leaking and alarming the owner about the leaky, and saving it to the cloud server. The components or hardware used are two water flow sensors, NodeMCU ESP32, and LCD Display. For application for owners to get notifications is Telegram as platform to inform the owners.

The plumber's services will cost a lot if the early-stage leaking is not taking seriously. The water pipeline will affect the water flow when the pipe is connecting. If the owner can be alert when the early leaking occurs, it will reduce the repair of water leaking pipelines. It will also help others to maintain the systemic water flow in the channel.

1.3 Project Objective

This project aims to propose a systematic and practical methodology to alarms the owner of the leakage from water pipelines.

Specifically, the objectives are as follows:

a) To understand the design water leakage detection in the house when the early stage leaking happen.

b) To detect the water leakage water leakage pipelines through the difference value of sensors input and output.

c) To monitor and analyze the pipeline house every time nonstop to ensure no leakage occurs while sending the notifications when leaks happen.

1.4 Scope of Project

The scope of this project is making to inform the features and components used in this project. Among this project's scope is using the NodeMCU ESP32 as microcontroller to control other parts as the head of the project. Next, the water flow sensor will sense the early stage leaking of the water pipeline. When the leaks occur, it will send the notifications to an application for alert the house owner. Finally, owners of the house can prevent the leakages to becomes more serious in the future.

2

LITERATURE REVIEW

2.1 Introduction

Nowadays, the waste of water due to leakage in water pipelines in the house is getting worse. The owner must be alarmed when the starting of early leaking to prevent more leakage in the future. The owner needs to pay more for it if the leakage breaks more, then the water will be more waste in the end. The leakages are mending at the early stage to reduce the waste of water. The owner also needs to know which pipe leaks to ease the owner to look up for it. The leakage's sound is analyzing to check whether it early or already harmful leakages on the pipelines.

Some leakages cannot be detected throughout the pipeline. It can waste the water, harm the other household structure, and encourage unwanted organic organisms that grow in the channel. We need to understand and look at how the leakage can happen in the pipeline.

2.2 Pipeline Structure

Figure 2.1 shows the pipeline structure, which includes several branches and nodes. Such a structure may be broken down into its essential components: two units and three nodes [3]. The microcontroller is placed from the sensor placed at each sub-pipe adjacent at the point more pipes branch. The flow sensor will be attached to the microcontroller to collects the data of flow rate.

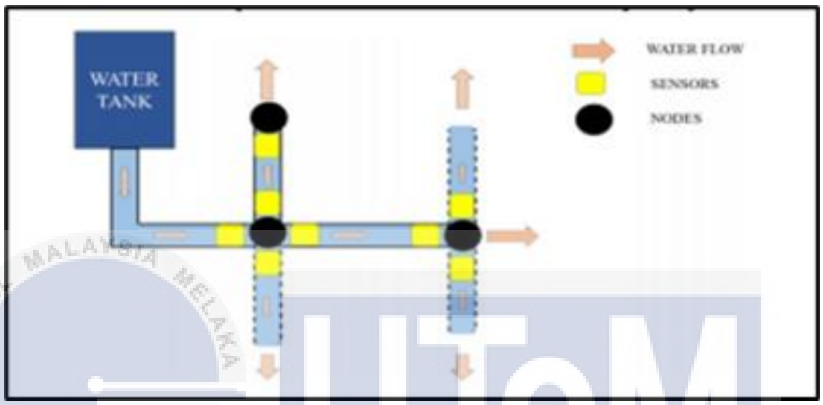

Figure 2.1 Generalized Pipeline Structure

2.2.1 Non-Revenue Water

Many countries around the world are concerned about NRW [7]. High NRW could imply a significant quantity of water loss before it reaches end-users, resulting in higher financial losses. According to the International Water Association (IWA), poor water resource management is one reason for NRW rates [6].

Physical (or actual) losses, commercial (or apparent) losses, and unbilled allowed usage are all components of NRW[6]. Water metering mistakes, billing irregularities, and unlawful consumption, such as water theft, are examples of commercial losses, sometimes known as apparent losses [17]. Water metering errors account for a significant share of commercial losses [6].

Through sophisticated water management systems, Singapore and Japan have significantly reduced their NRW rate [6]. Other research has found that good water management is critical to lowering NRW losses [16]. However, NRW continues to be a problem, particularly in Malaysia. One of the key contributors to this problem is a lack of public knowledge of the severity of the NRW problem and a belief that such a situation is solely the responsibility of the water authorities [1]. Furthermore, the lack of a unified government policy on water security and budget constraints hinders NRW reduction projects' implementation [2]. As a result, it is critical to understand the elements that contribute to NRW so that an effective water management system can limit and regulate the NRW rate.

2.3 Categories of Pipes

There are many different types of plumbing pipes available today, some of which are ancient classics and others built of contemporary materials. When deciding the sort of pipes to utilize in our home's plumbing system, we need to weigh the benefits and drawbacks of each of these materials.

2.3.1 Polyvinyl Chloride Pipes

Figure 2.2 PVC Pipes

Figure 2.2 shows PVC pipe is the most commonly used for draining and vent lines. It has become popular and well-known as a result of its lightweight and ease of use.

Galvanized steel pipe is more difficult to deal with than PVC pipe. It is also quite simple to put together and cut into parts for our purposes. It is simple to glue PVC pipes together, and all that is required is a solvent.

PVC is a low-cost material that used for a long time. Before purchasing a pipe, check the diameter listed on the pipe's surface. PVC cannot be un-connected after it has been connecting, so we will have to cut it. PVC pipes that have been glue together are occasionally prone to leaking.

2.3.2 Cast Iron Pipes

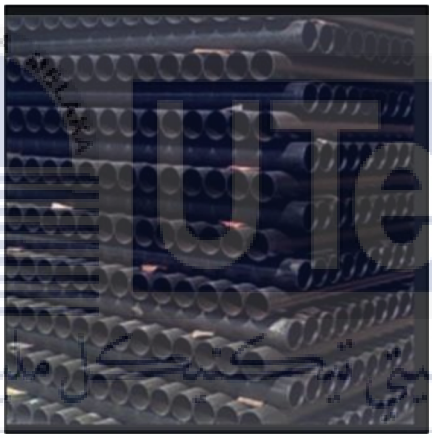

Figure 2.3 Cast Iron Pipes

These plumbing pipes are pricey and have threaded connections. Cast iron pipes are heavier than PVC and other conduits, making them ideal for a water distribution system underground. Because of its robustness and extended life, cast iron pipe makes up most municipal pipelines, as Figure 2.3. Pipes made of cast iron can be utilized until they corrode entirely. These pipes are extremely tough to resize and cut. They are primarily used for gas distribution, drainage, and water distribution. On the other hand, ductile iron pipes have the advantage of a clean tapping procedure utilizing specialist tools, which lowers the need for welding and installation abilities [20].

2.3.3 PEX Pipe

Figure 2.4 PEX Pipe

PEX pipe is a new product on the market, as well as in the plumbing industry. It is purely for water supply. PEX pipe has the benefit of being stiff and durable. It can withstand water pressure. Because it is flexible, it can weave around walls and crawl spaces.

2.3.4 Rigid Copper Pipe

Figure 2.5 Rigid Copper Pipe

Within the home, rigid copper pipe is typically utilized for water supply lines. It is pretty simple to cut. With a hacksaw, it is possible to cut it. A stiff copper pipe connection differs from others in that soldering copper pipes together takes practice. It has no dangerous precautions and is suitable for water supply. The pipe is flexible despite its rigidity. It can tolerate high temperatures and pressure.

2.3.5 Galvanized Steel Pipe

Figure 2.6 Galvanized Steel Pipe

For many years, galvanized steel pipe has been utilizing for drainage, water delivery, and gas delivery. It can also be used for other things. However, it is rarely employed in the present era, notably for water delivery in new residences. The threaded ends of the galvanized steel pipes are screwed together using joints. These pipes are pretty durable, but they can corrode and obstruct water flow.

2.4 Causes of Water Pipeline Leakages

A water leak is the last thing any homeowner wants to deal it. Some individuals disregard the signs of a water leak because they are terrified of what they might find if they poke around behind walls and near pipes. Nobody enjoys hearing a leaking faucet drip, drip, drip. Corroded pipes leak, causing a slew of issues for homeowners. Leaks can be as minor as a leak, yet they may also cause significant damage to our house and property.

2.4.1 Poor Maintenance Causing High Water Pressure

One of the most common causes of inter-floor leaks has been discovered as leaking home plumbing. It occurs on rare occasions in buildings with plastic pipes and corroded metal pipes that can explode under high water pressure.

Water hammering occurs when flowing water is abruptly turned off, generating a pressure surge in the pipes' interior walls. High water pressure can also be caused by poorly maintained pressure reduction valves and other plumbing fixtures.

2.4.2 High Water Pressure

High water pressure may wreak havoc on the pipes. The average water pressure in the house should be 60 psi (pounds per square inch), with the plumbing system built to tolerate up to 80 psi. Water pressure that is too high is typically out of our control. High water pressure can be caused by living in areas with hills, large buildings, or close to fire hydrants.

2.4.3 Corroded Pipes

Corrosion in pipelines is an inevitable challenge. Even if homeowners insulate the metal to keep it from rusting, rusted pipes will ultimately occur. When lines get corroded, pinholes can develop, resulting in minor leaks. Coating wear and tear is the leading cause of corrosion in steel water pipelines. Negligence and incorrect coating application are frequently to blame for these occurrences [19].

High or low pH values in the water are the most common causes of pipe corrosion. The pH scale determines how acidic the water is. pH test strips may be purchased at any

hardware shop to determine the pH level of the water. The pH level of the water should be between 6.5 and 8.5.

2.5 Technique Detecting the Leaking.

A water leak that is detected early on might save money and prevent disaster. Some signs should be considered when the early stage is happening. The owner must regularly check the water meter by turn off all water in the house. If the leaks occur, the water will still run. Next, monitor water bills last several months and latest months by comparing them to see if any constant rises. Checks exterior usage also need to do. This due to leaks does not just happen inside the home, and it also occurs outside. Even a minor leak in a system can waste 6,300 gallons of water every month.

Based on Grace et al., 2019 [3], the article compares the technique that other authors already completed their research on water leakage. Firstly, when the author [9] uses correlators to detect the leakage, it may have some advantages and disadvantages when using it. It may detect leakage using arithmetic correlation of parameters that it needs to look at it. For light-dependent resistors [10], most of it uses in industrial applications but not at home, so that it is the disadvantage of it while it cannot work in a high-risk setting. Then, the vibration sensor is modified with an ML prefilter [4], the sensors can be separated at a greater distance, and sensor installation can be cut. Next, for fiber optic sensors that [5] use to detect the leaks, it is easy to use, high accuracy, and quick response time. Thus, the response is speedy for signal processing techniques, and it can detect the leaks trouble-free. Finally, the method that other researchers use can be used to detect the leakages.

2.6 Comparison Between Varieties Sensors Used for Detecting Leakages

Table 2.1shows the comparison of technique or varieties of sensors to detect the water leakage.

TYPES	PROS	CONS
Correlators [9]	1. For leakage detection, arithmetic correlation of time delay, zone size, and sound proliferation rate of the pipe are parameters to look at it.	1. The size and consistency of the pipes play a role. 2. For larger diameter pipes, concrete pipes, and PVC pipes, they are less effective. 3. To track long pipes, they must be relocated regularly.
Light Dependent Resistor [10]	1. The water distribution is being tracked in real-time here.	1. The Pipeline Inspection Gauge (PIG) subsystem combined with the industrial applications' detection and GPS receiver system. 2. Cannot work in a high-risk setting.
Vibration Sensor with modified ML prefilter [4]	1. A greater distance can separate sensors than in traditional systems. 2. As a result, the cost of sensor installation can be reduced.	1. High-frequency noise makes it sensitive.

Fiber Optic Sensors [5]	1. It is easy to use. 2. High precision. 3. The response time is speedy.	1. The maintenance costs are substantial, and the scale of the leak is impossible to predict.
Signal Processing Techniques [11]	1. There is a quick response time. 2. Detecting a leak is simple.	1. It is difficult to put into practice. 2. The accuracy is moderate. 3. Expensive to operate. 4. There is no way to determine the extent of the leak.

Table 2.1 Comparison Between Various Sensors

2.7 Effects of Water Leakage in the House

Water damage has been shown to have a significant impact on a home's market value and aesthetic. We all know that severe flooding can be devastating to your property and result in tens of thousands of dollars in repair expenditures. Unfortunately, a water leak can be just as damaging to our health and property as a full-fledged flood. Here are just a few of the repercussions of a minor water leak to help us realize the perils of even a tiny bit of water damage and the threats it poses to our health and home.

2.7.1 Health Factor

Water leaking and mold could have a substantial health impact in addition to causing damage to our home and diminishing our net worth. Molds produce spores, which are known to harm the environment. These tiny little spores have the potential to be disastrous to our long-term health since they can permeate the air we breathe and hence have an impact on how our bodies function.

Molds can easily multiply when they come into touch with water, leading to a variety of issues. Due to molds, some persons experienced trouble breathing, coughing, and even sneezing fits.

Furthermore, if you have a dust allergy or are suffering from asthma, the scenario could be disastrous, potentially resulting in health difficulties. Babies in houses with small children are at a high risk of acquiring asthma due to inhaling irritated, polluted air.

Furthermore, the unpleasant odor commonly linked with mold and fungal growth degrades your quality of life. When people remain in such places, they tend to be irritable and uncomfortable, which affects their mood and causes behavioral changes.

2.7.2 Mold Growth

Mold and fungal development are prone to occur if there is an unattended water leak in our home. When the leaked water sits on the surface for a lengthy amount of time, it causes the area to get moist, leading to widespread mold contamination. Furthermore, water loss can penetrate any porous binding substance, resulting in extensive mold development in multiple locations.

Mold infestations can result in a significant amount of repair costs because they weaken the general structure of the affected area. They can cause the wood to become useless and possibly cause fissures. Furthermore, it can sometimes produce a foul odor, necessitating extensive cleaning of the area. Staining is also fairly prevalent, as the infected region may take on a new hue, or the colored area may begin to discolor as well. There are also a lot of yellowish stains.

Depending on the intensity of the mold contamination, the damage could be extensive, necessitating the uprooting of the soil and treatment of the surface. It just takes 24 to 48 hours for mold to start growing when there is dampness. As a result, we can see how untreated water leaks pose a significant hazard to our home. Mold and water leaking could dramatically diminish the net worth of our property if you decide to have it appraised.

2.7.3 Sagging Walls

If the leak is in the roof, it could cause problems with the walls. The presence of stagnant leaking water could weaken the ceiling and wall and cause drooping over time. When water leaks occur in unexpected places, mold and fungi may continue to grow within, compromising the entire structure of your home. They erode the insides of your pipes and

weaken the foundation of your house. As a result, we must act quickly and effectively to address the issue as soon as it arises.

2.8 Summary

In conclusion, I stated that by how the pipeline structure in our house looks like it. It can be in the kitchen, toilet, or outside of the house; the leakage can happen without knowing it. Here, I am listing what pipe we use in our daily lives, whether we use it without knowing it. The types of tubes can be used for the plumber to replace the pipes that leak. Next, I started the reasons for leakages that happen in the home. Poor maintenance when we do not check it correctly, the corroded pipes when keep using it can be rusted, and high-water pressure when the water flows through the pipes. Then, I refer to how we can detect the leakage in the pipeline on the journal of an article and other projects. Lastly, we must know what will happen when we do not take leakages seriously in our lives.

3

METHODOLOGY

3.1 Introduction

In this project, I stated how my project would be conducted by showing the flowchart, block diagram, and hardware and software when the owner receives the notification and the sound to analyze it. It, too, shows how my project flows and whether it will meet the project's requirement to proceed to our society. Next, it can help me follow my project step by step and know the function of my hardware and software to detect the leakages.

3.2 Project Workflow

The flow of the project will be based on the first and last things that my assignment completed. I will be planning the implementation or how my project will be completed. Then, I will research my other researchers that already complete that the almost same as my project. The hardware and software that I will use in my project will design by design the block diagram. Next, the implementation of my project will utilize my hardware and software to connect it through my research. Finally, the output will be analyzed to show the outcome that I want and the homeowners that will use in society.

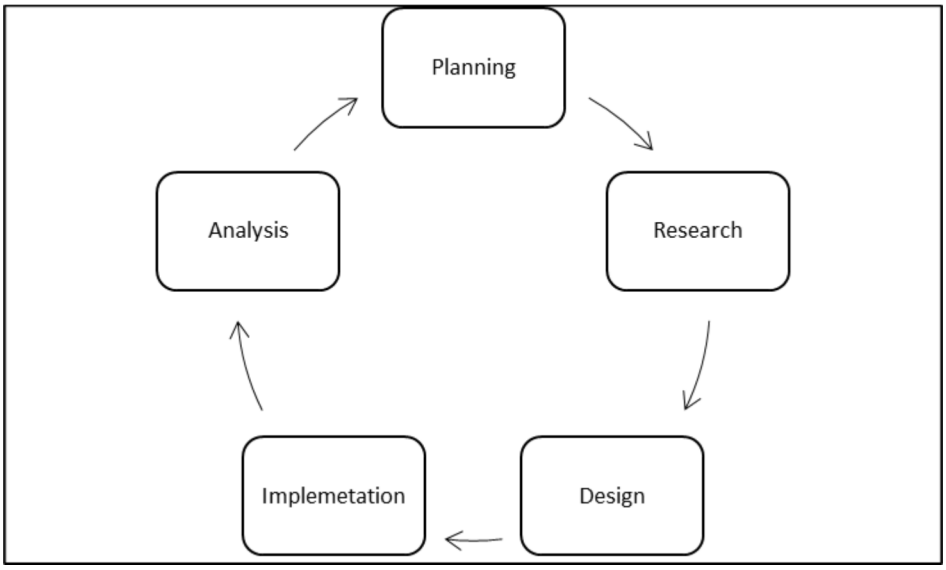

Figure 3.1 Project Flow

3.3 Planning

The primary step to do the project is to plan how my project will implement throughout my study. Therefore, the primary goals to complete my project will achieve. The main purpose of my project is to give the owner notification when water leakage happens, and the owner also can monitor the sensor when he or she wants it. The objectives of this project will meet the requirement when we plan it nicely. Gantt Chart BDP 1 and Gantt Chart for BDP 2 is created to show my plan throughout this semester.

3.4 Flowchart of Final Year Project

This is my flowchart of my project for final year project of my study like in Figure 3.2.

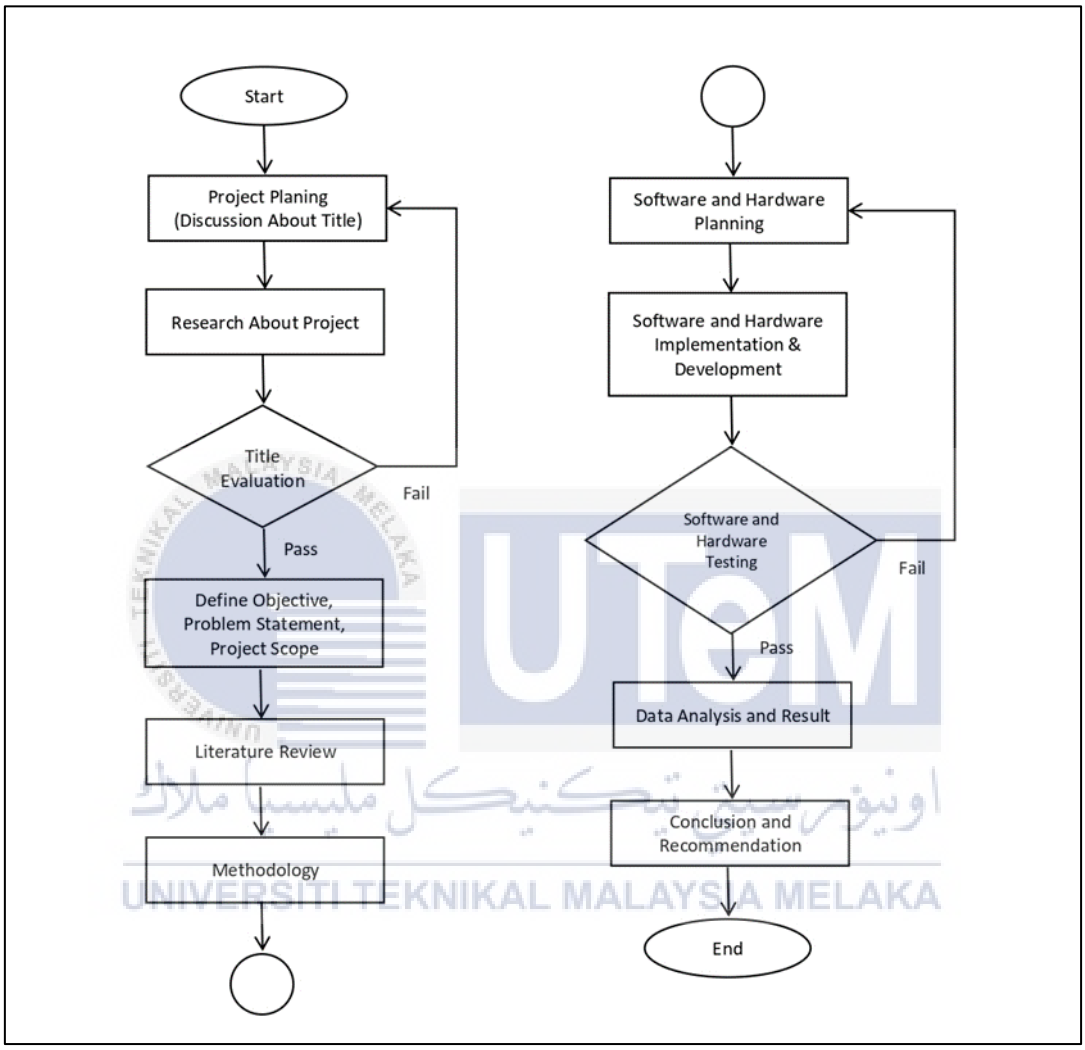

Figure 3.2 Flowchart of Final Year Project

3.5 Gannt Chart for BDP 1

Here is my Gantt chart for overall project flow during BDP 1 for my final year project.

Week / Activity	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Project Group Title														
Objective, Problem Statement														
Abstract, Scope of Project														
Introduction														
Literature Review														
Methodology														
Assemble the hardware														
Submit Report														
Presentation														

Table 3.1 Gantt Chart BDP 1

3.6 Gantt Chart for BDP 2

Here is my Gantt chart for project flows and progress flow during BDP 2 for my final year project.

Week / Activity	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Planning Requirement Project														
Design and Analysis the Project														
Develop Hardware and Software														
Complete Report for Chapter 4 and 5														
Submit Draft Report														
Report Correction														
Complete Whole Project														
Complete Poster														
Submit Report to Panel														
Prepare Slide Presentation														
BDP2 Presentation														

Table 3.2 Gantt Chart for BDP 2

3.7 Methodology of Project

For my project, the flowchart is given as below on Figure 3.3. For the start of my project, I start it by release the water through pipelines and make it flow on the two water sensors which are label In and Out. Next, the system will calculate the flow rate In and the flow rate Out of water flow sensors. The system will check either the leakage is happened or not when water flow through pipelines. If leakages happen, flow rate Out is less than one per three of flow rate In, LCD screen will display "ALERT LEAKAGE DETECTED" and immediately send notification "LEAKAGE DETECTED" through Telegram to alert the owner when leakage happen. Meanwhile, if no leakages detected, it would just flow continuously until leakage detected and display the flow rate In and flow rate Out.

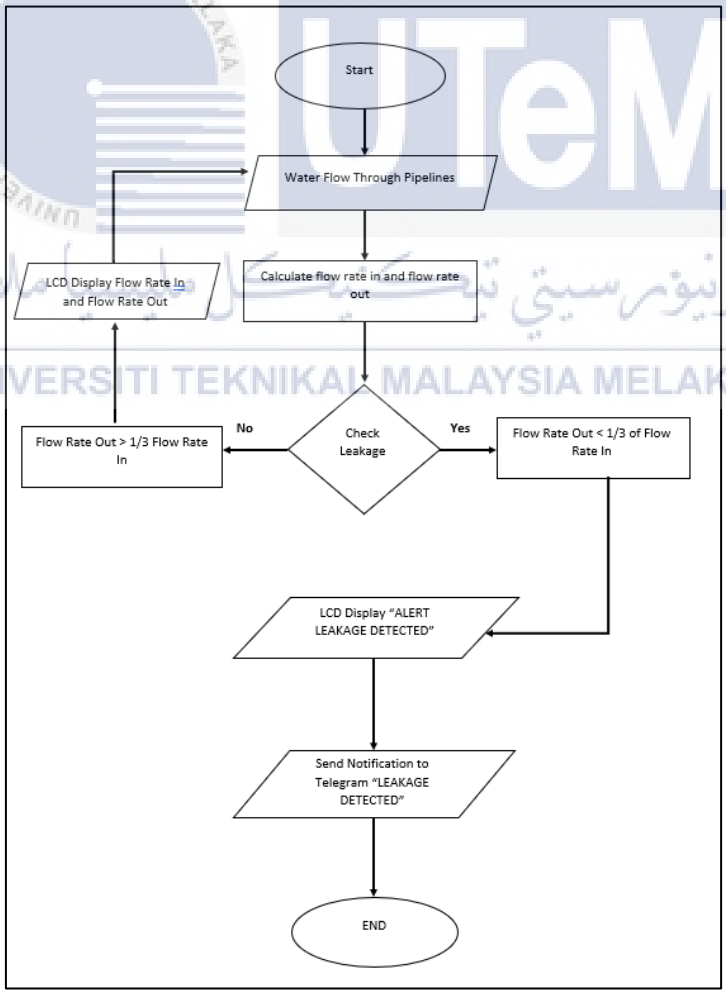

Figure 3.3 Flowchart of Project

3.7.1 Experimental Setup

For this setup, I list out the component that I will use in my project. The input will be the water flow sensor that I will use to detect the leakage of water pipelines. Next, the data that I get when flow sensor collecting data of rate will be process by NodeMCU ESP32. Lastly, for the output, LCD screen will display flow rate In and flow rate Out. For Telegram, owners will receive notification when leakage happen and alert the owners when it happened.

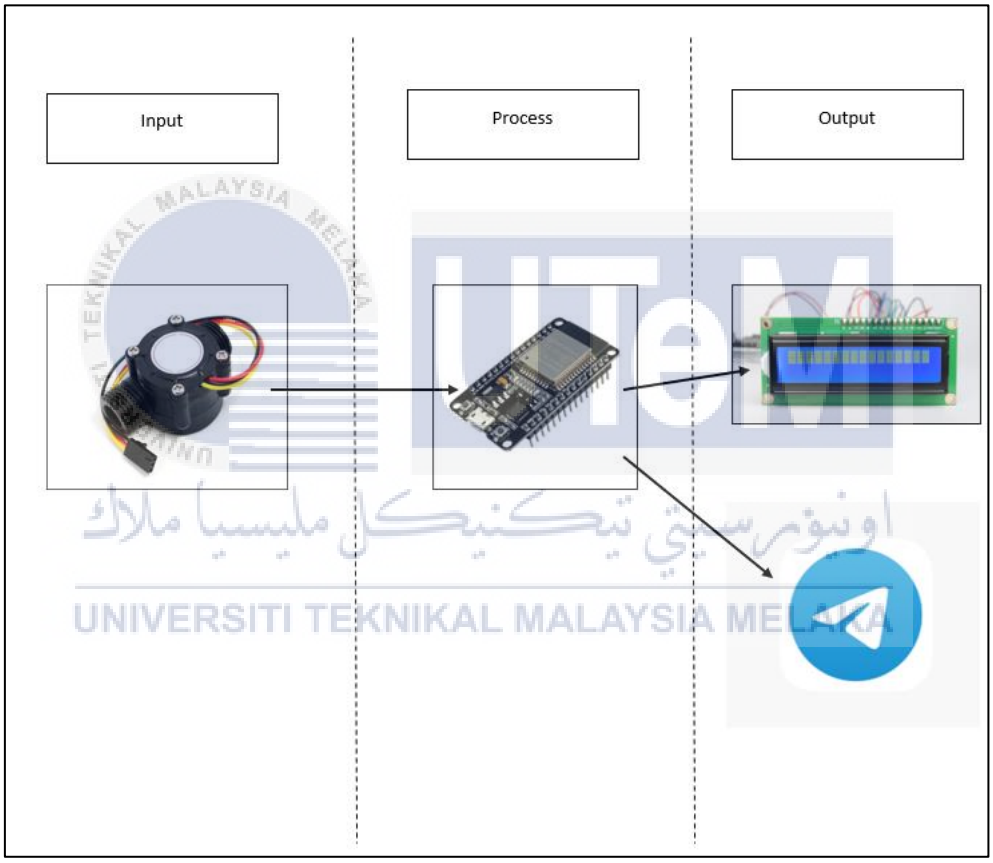

Figure 3.4 Block Diagram of Project

3.7.2 Hardware Implementation

For connection hardware, I use two flow sensors which will label as IN and OUT because to calculate the flow rate in and out. For flow sensor IN, the red connecting will be go to Vin, for yellow wire will be connect to pin 18 and lastly for black colour wire, I will connect it to ground. Then, for flow out sensor, red connecting wire will be connect to Vin, yellow will be go to pin 19 and black colour will be go to ground section. Lastly, for LCD screen, GND port will coneect to ground part, VCC port will go to Vin, meanwhile SCL port will go to pin 22 and SDA port go to pin 21.

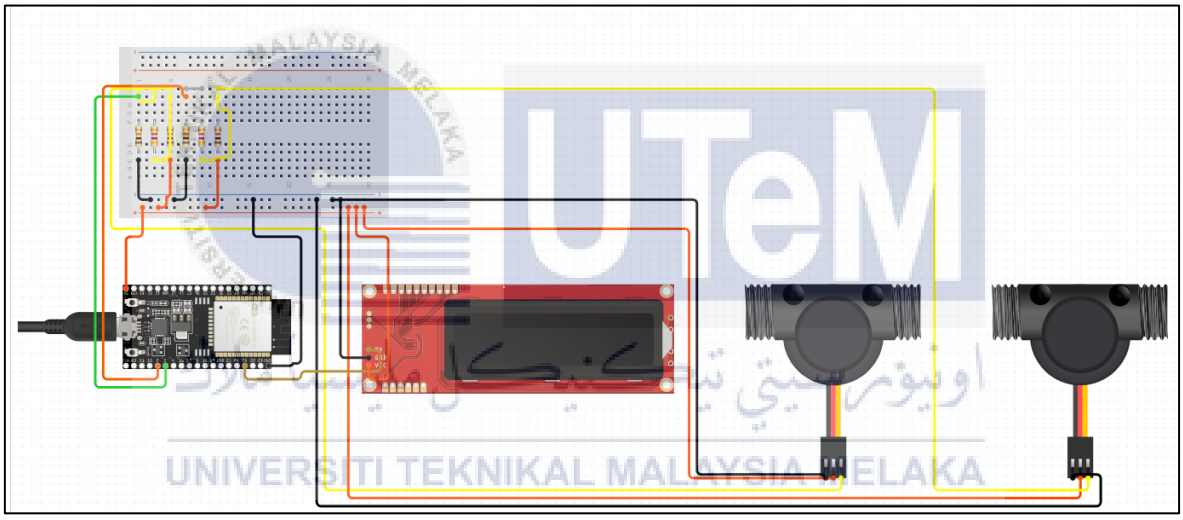

Figure 3.5 Hardware Connection

3.7.2.1 Equipment

It will be the component that I will use to have input, process, and output for hardware. It will have the sensor, the brain of the microcontroller system, and where the outcome will be displayed when the data is received.

3.7.2.1.1 NodeMCU ESP32 Board

NodeMCU ESP32 is a breadboard-friendly version of the ESP-WROOM-32 module, allowing me to construct my project utilizing this tiny microcontroller. This microcontroller-based ESP-WROOM-32 module and ESP32 DEVKIT DOIT. It also built-in 2.4 GHz Wi-Fi and Bluetooth with ESP32 dual-core 32-bit processor. It needs in my project because I want it to connect it with the owners' phone while giving the alarm. It also features 4Mbyte flash memory, 520Kbyte RAM, and a 2.2 to 3.6V operating voltage range.

Figure 3.6 NodeMCU ESP32 Board

3.7.2.1.2 LCD Display

The LCD display is utilized to see data that is helpful for analysis by users. Here, a 16*2 LCD display is employed. The Arduino UNO is connecting to data lines 4-7. The LCD will display my output programmed on NodeMCU ESP32.

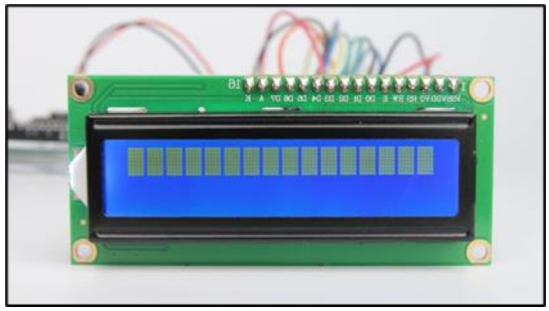

Figure 3.7 LCD Display

3.7.2.1.3 Flow Sensor

This sensor determines the rate of flow of water or any other liquid. The flow sensor's red wire connects to VCC, and the black wire is connected to the ground and the yellow wire links to any of the GPIO pins [13]. Each time a certain amount of water travels through the pipe, the sensors send out a digital pulse [8]. It has a pinwheel rotor with several rotations proportionate to the amount of water flowing through it. It works based on the Hall Effect [3]. As the rotor revolves, an interference with the Hall Effect sensor occurs, resulting in a pulse. As a result, two flow sensors are installing in a pipe. When a pipe leaks, the flow sensor at the outlet will have a different value than the flow sensor in the inlet. The flow rate ranges from 1 ~ 60L/min. The operating temperature is ≤80°C. The water pressure tolerance ≤1.75MPa (Max 2MPa). Storage temperature needs to be -25°C～+80°C [8].

Figure 3.8 Flow Sensor

3.7.2.2 Software

The software section will provide the notification on an application for notify the host when leakage happen while also a platform to run the system.

3.7.2.2.1 Telegram

Telegram is a messaging app with a focus on speed and security, it's super-fast, simple and free. Owners can use Telegram on all his devices at the same time which smartphones and laptop. Telegram will be use as a platform to receive notifications and alert the owners when leakages detected.

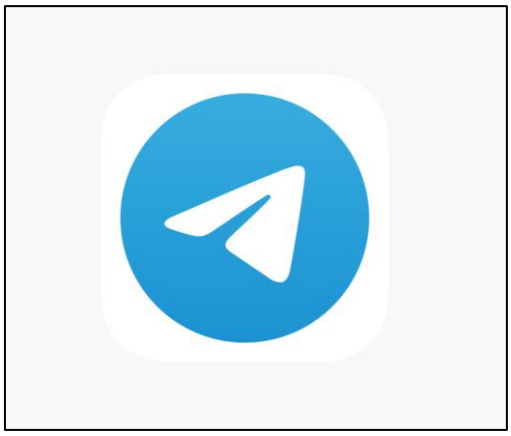

Figure 3.9 Telegram Logo

3.7.2.2.2 Arduino IDE

Arduino IDE is an open-source programme created by Arduino.cc that is used to write, compile, and upload code to practically all Arduino Modules. On the board of each of them is a microcontroller that has been programmed and accepts data in the form of code.The core code, also known as a sketch, written on the IDE platform will eventually generate a Hex File, which will be copied and uploaded to the board's controller. For my project, I use it as my main function of system to code the system that I will use it to run it on myproject and connect it through Wi-FI while give notifactions to the owner.

Figure 3.10 Arduino IDE Logo

3.8 Limitation of proposed methodology

Nonetheless, these results must be interpreted with caution, and several limitations should be borne in mind. Limitations when doing this project are the lack of previous research studies on the topic, the technique used to collect data, and time constraints. Firstly, as I am doing my project's research, I lack the latest research study to make it my reference and put it in the literature review section. Many studies about detect leakage underground

pipelines but lack of when detecting the leakage in the house. Next, the technique used to collect data is one of the reasons for limitations. When I read and review the others study project, not so many of them using surveys as their technique, the survey can make it more compatible because asking about their problem and how they manage to overcome it.

3.9 Summary

The methodology section, it is to explain what hardware and software that I use for my project. For hardware, I list out all components that I will use in my project and details of usage on each of them. Furthermore, the software that I will use are Arduino IDE as main features to create my system how my project function while Telegram as my application to get notifications when leakages happen. Then, in methodology, I also show a Gantt Chart for my project process, a block diagram for input, process, and output of the component. Finally, a flowchart for my project will start and go through the sensor and receive the outcome.

4

RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter shows about my output that I get from connecting the software and hardware from my project. The result will be collect and tabulated in the result segment and will be analyze why it happen. The owner will receive notification when leakage detected from the system. The owner can go anywhere and anytime while without worrying if leakage happen because it will send the notifacation when early leakage detected and owner can take action when the system notify him or her.

4.2 Results and Analysis

The results that I collect from my project is tabulated below which Table 4.1.The project flows is running an hour throughtout the project. The time betwwen 11.14 p.m to 11.44 p.m is still maintain the flow in and flow out. After 11.44 p.m leakage is happen, hence flow rate out is lower than flow rate in. The leakage will be detected, when one-third of the flow rate in is larger than flow rate out.

The LCD will display an alert on the screen to shows that the leakage happen in every single moment. If it is more than four times it shows on the screen, it will notify the owners through Telegram.

Time / FlowRate	IN (L/Min)	OUT (L/Min)	Leakages= IN/3 (L/Min)
11.14 p.m	7.33	7.55	2.44
11.24 p.m	7.55	7.55	2.52
11.34 p.m	7.33	7.33	2.44
11.44 p.m	7.33	7.33	2.44
11.54 p.m	7.33	6.88	2.44
12.04 a.m	7.33	5.11	2.44

Table 4.1 Data from LCD Display and Leakages Calculation

The LCD screen will be display as Figure 4.1 like figure below. This is one of the example how I get my data that I tabulated from LCD screen.

Figure 4.1 LCD Display In and Out

So when the flow rate out is less than one-third of flow rate in, it will pop up "ALERT LEAKAGE DETECTED".

Figure 4.2 Leakage Detected and LCD Screen Show the Alert

For notify through the Telegram application, the owner will get notification "LEAKAGE DETECTED" when LCD shows the the alert for about four second then notify the host immediately.

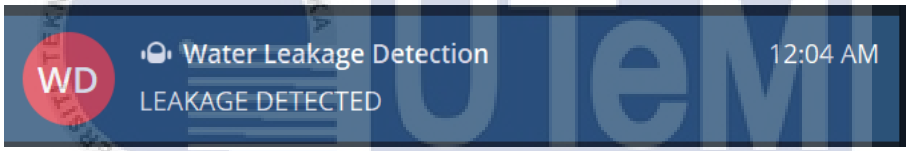

Figure 4.3 Telegram Notification When Leakages Detected

4.3 Summary

This chapter showed water pipeline leakage detection model. Leakage is identified by utilizing water flow sensors and correspondence is done remotely. Leakage can be known when the flow rate out is less than one-third of flow rate in. NodeMCU ESP32 is used as managing the system that I send and also connecting the Wi-Fi for sending the notifactions when leakages happen. When first four seconds is displayed on the LCD display is "ALERT LEAKAGE DETECTED", Telegram will receive a signal to send the notification "LEAKAGE DETECTED" that leakage is detected so that it will alert the owner to stop the leakage immediately.

5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

This papers presents water pipeline leakage detection model. Leakage is identified by utilizing water flow sensors in and out to shows that the leakage is happen. One-third of water flow sensors in, if more than flow rate out, it will display on the screen an alert to shows the leakage is identified. Next, if it more than four times consecutively detected, it will notify the system to send notifications throughtout the Telegram applications. The owner can alert when early leakage is detected eventhough he or she does not at home.

NodeMCU ESP32 is use as main microcontroller of the system in the entire project. It must be connected to Wi-Fi, so that the notifications can be send immediately. This prototype gives ongoing leakage present in the pipeline. There are still a lot of improvement can be done to make it more user-friendly for future use.

5.2 Future Works

For time ahead development, it can be improve to make it has more features and make it user friendly such as

i. Adding a cloud computing to save the data in the database so user can monitor it.

ii. Add a sound buzzer to alert the owner that in the house to check the water pipelines without see the notifications on the phone.

iii. The distance between flow sensor in and out can be longer so that more accurate data can be taken.

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APPENDICES

Appendix A Coding of the System

```
volatile byte pulseCountOUT;
byte pulse1SecOUT = 0;
float flowRateOUT;
unsigned int flowMilliLitresOUT;
unsigned long totalMilliLitresOUT;

LiquidCrystal_I2C lcd(0x27, 16, 2);
WiFiClientSecure client;
UniversalTelegramBot bot(BOTtoken, client);

void IRAM_ATTR pulseCounterIN()
{
  pulseCountIN++;
}

void IRAM_ATTR pulseCounterOUT()
{
  pulseCountOUT++;
}

void setup()
{
  Serial.begin(115200);
  lcd.begin();
  lcd.backlight();
  pinMode(SENSORIN, INPUT_PULLUP);
  pinMode(SENSOROUT, INPUT_PULLUP);
```



```
#include <WiFi.h>
#include <WiFiClientSecure.h>
#include <UniversalTelegramBot.h>
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
#define SENSORIN 18
#define SENSOROUT 19

const char* ssid = "Che_Bedah 2.4GHz@unifi";
const char* password = "che123bedah45";
#define BOTtoken "5031868674:AAGgeDu-r5q_adJQjoxPBtW5X1k1UWC9bRI"  // your Bot Token (Get from Botfather)
#define chat_id "271066361"

int con = 0;
float leakage = 0;
long currentMillis = 0;
long previousMillis = 0;
int interval = 1000;
float calibrationFactor = 4.5;
volatile byte pulseCountIN;
byte pulse1SecIN = 0;
float flowRateIN;
unsigned int flowMilliLitresIN;
unsigned long totalMilliLitresIN;

volatile byte pulseCountOUT;
byte pulse1SecOUT = 0;
float flowRateOUT;
unsigned int flowMilliLitresOUT;
```

```
void loop()
{
  currentMillis = millis();
  if (currentMillis - previousMillis > interval) {

    pulse1SecIN = pulseCountIN;
    pulseCountIN = 0;
    pulse1SecOUT = pulseCountOUT;
    pulseCountOUT = 0;

    flowRateIN = ((1000.0 / (millis() - previousMillis)) * pulse1SecIN) / calibrationFactor;
    flowRateOUT = ((1000.0 / (millis() - previousMillis)) * pulse1SecOUT) / calibrationFactor;
    previousMillis = millis();

    flowMilliLitresIN = (flowRateIN / 60) * 1000;
    flowMilliLitresOUT = (flowRateOUT / 60) * 1000;

    totalMilliLitresIN += flowMilliLitresIN;
    totalMilliLitresOUT += flowMilliLitresOUT;

    leakage = flowRateIN / 3;
    Serial.print("Flow rate: ");
    Serial.print(flowRateIN); // Print the integer part of the variable
    Serial.print("     ");
    Serial.print(flowRateOUT); // Print tab space
    Serial.print("     ");
    Serial.println(leakage);



   if (flowRateOUT < leakage) {
     con++;
     lcd.setCursor(0, 0);
     lcd.print("     ALERT                          ");
     lcd.setCursor(0, 1);
     lcd.print("LEAKAGE DETECTED");
     if (con == 4) {
       bot.sendMessage(chat_id, "LEAKAGE DETECTED");//hantar msg ke telegram
     }
   }

   else {
     lcd.setCursor(0, 0);
     lcd.print("IN: " + String(flowRateIN) + " L/min      ");
     lcd.setCursor(0, 1);
     lcd.print("OUT: " + String(flowRateOUT) + " L/min          ");
     con = 0;
   }

  }
}
  pulseCountIN = 0;
  flowRateIN = 0.0;
  flowMilliLitresIN = 0;
  totalMilliLitresIN = 0;
  previousMillis = 0;

  pulseCountOUT = 0;
  flowRateOUT = 0.0;
  flowMilliLitresOUT = 0;
  totalMilliLitresOUT = 0;

  WiFi.mode(WIFI_STA);
  WiFi.begin(ssid, password);
  while (WiFi.status() != WL_CONNECTED) {
    delay(1000);
    Serial.println("Connecting to WiFi..");
  }
  Serial.println(WiFi.localIP());

  attachInterrupt(digitalPinToInterrupt(SENSORIN), pulseCounterIN, FALLING);
  attachInterrupt(digitalPinToInterrupt(SENSOROUT), pulseCounterOUT, FALLING);
  lcd.clear();
  lcd.setCursor(0, 1);
  lcd.print("Codes 0x");
}
```